# WATER QUALITY RESEARCH--THE PRESIDENT'S INITIATIVE

## PROGRAM REVIEW AND EVALUATION
## 1992

## PRIORITY COMPONENTS

# SUMMARY

## SOUTH AND WEST REGIONS
## COMBINED

Agricultural Research Service
Cooperative State Research Service
U.S. Department of Agriculture

in Cooperation
with

State Agricultural Experiment Stations
and other Collaborators
at
Baton Rouge, Louisiana
Tucson, Arizona

ACKNOWLEDGEMENT

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Baton Rouge, Louisiana and Tucson, Arizona were selected as sites for the southern and western regions, respectively. Planning was largely through efforts of administrators and scientists of the State agricultural experiment stations (SAES), ARS and CSRS. We appreciated guidance from SAES administrative advisors for water quality V. V. Volk, Oregon and J. M. Davidson, Florida. Significant assistance was provided by C. B. Rumburg, J. M. Horton, and B. L. Schmidt of CSRS, D. A. Bucks, ARS, H. Mattraw, U.S. Geological Survey, and others. In addition to the above, effectiveness of the meetings was enhanced through participation by representatives of the Extension Service, Soil Conservation Service, Economic Research Service and the fertilizer and chemical industries.

Members of the Evaluation Panels for the two meetings are the following. They are also listed as Work Shop Participants at the end of each Research Problem Area (RPA) work group report.

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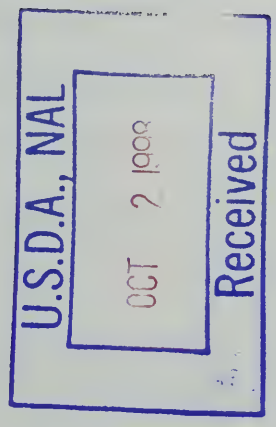


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Appreciation is extended to these panelists for many hours of study and evaluation of the large number of abstracts and progress reports prepared by the researchers. Their analysis reports at the beginning of the meetings were a stimulus for discussions that followed in the respective RPA Work Groups. Their final reports, contained herein, show many important accomplishments of this young research program. And, the recommendations from the work groups provided guidance for emphasis in the forthcoming request for proposals of research for the fiscal year 1993 competition.

A special thanks is extended to the hosts and local organizers, whose efforts were largely responsible for efficiency of program operations and a very warm welcome. Some of those for Baton Rouge were H. R. Caffey, Chancellor, Louisiana State University (LSU) Agricultural Center and K. W. Tipton, Vice Chancellor/Director, and arrangements organizers H. M. Selim, LSU, and J. L. Fouss and G. H. Willis, ARS. University of Arizona (UA) hosts were E. G. Sander, Dean and P. J. Wierenga, Soil and Water Science-Head, arrangements organizer was A. W. Warrick, UA, with assistance by L. J. Lane, ARS and others.

The evaluation and review process and the Comprehensive Reports and Summary were coordinated and edited by C. M. Smith, Visiting Professor, Pennsylvania State University.

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## FOREWORD

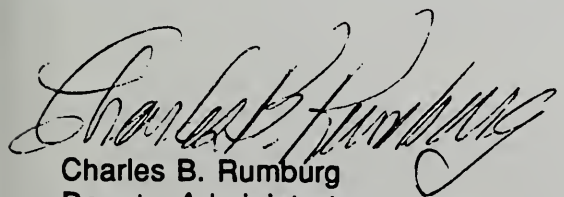
The use of pesticides, fertilizers, manures and wastes contributes substantially to the productivity and efficiency of agriculture and to the well-being of rural and urban communities. There are concerns, however, about contaminant risk to human health, water quality, and an ecologically stable environment. The President's Initiative on Water Quality was initiated in 1990 to provide new and expanded emphasis on the protection and enhancement of our water resources.

This action provided major impetus to the USDA Water Quality Research Plan developed jointly and implemented in 1989 by the Agricultural Research Service (ARS), the Cooperative State Research Service (CSRS), the State agricultural experiment stations and other agencies. The need for a far-reaching research effort on water quality problems related to agriculture was recognized, fostering an effective partnership accomplished through collaborative administrative and research efforts among USDA, U.S. Geological Survey, the Environmental Protection Agency, and State experiment stations.

This report is the result of formal water quality research program evaluations and reviews in 1992 at Baton Rouge, Louisiana and Tucson, Arizona for the South and West regions, respectively. It portrays high priority problems needing research along with recommendations of changes in program emphasis. The recommendations reflect concerns from a broad spectrum of participants including researchers in areas of expertise relevant to water quality, technologists and specialists from the Soil Conservation Service and the Extension Service (Federal and State), and representatives of the fertilizer and pesticide industries. Similar evaluations for the North Central and Northeast projects given in the 1991 report provided guidance for this year's activities.

Abstracts for the two types of research projects of the water quality program, the Priority Components and the Selected Geographic Systems--Management Systems Evaluation Areas (MSEA) are included in the appendices of the comprehensive reports. These concise abstracts report progress of research inspired and funded in part by the President's Initiative program of ARS and CSRS. It is apparent that several of the awards "bought into" ongoing research projects yielding quicker results for use by agricultural producers. Outstanding research is underway in both programs. Onsite reviews of the MSEA projects in 1991 produced recommended changes implemented in 1991 and 1992. Adoption of results from the five major MSEA projects in the Midwest is essential. Researchers are working with education and technology transfer specialists to achieve this goal.

Interactions among meeting participants were useful from a program management view, as well as to communicate research progress and roadblocks. The significant accomplishments achieved during the past two years, and the knowledge developed through future research, will greatly enhance our understanding of fate and transport of potential contaminants in soils and water. And, these accomplishments will facilitate the adoption of economical and environmentally acceptable agricultural production systems to avoid or reduce pollution and enhance surface and groundwater quality.



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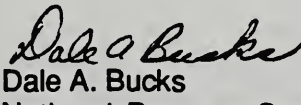

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# WATER QUALITY RESEARCH: THE PRESIDENT'S INITIATIVE
# PROGRAM REVIEW AND EVALUATION, 1992

for

South Region, Baton Rouge, Louisiana and West Region, Tucson, Arizona

## SUMMARY

### BACKGROUND

The deterioration of water quality or the potential for it, resulting from the use in agriculture of certain pesticides, fertilizers, manures, and sludges, is a problem of major concern to rural and urban people and scientists. The development of effective and economically feasible technologies that avoid excessive concentrations of potential contaminants, or remediate problem conditions, requires a comprehensive understanding of what happens to chemicals and other products in soils and water and the appropriate application of information. Research in agriculture was given major impetus by new emphasis on water quality in the statement of an Initiative by The President.

"The protection of the environment and the conservation and wise management of our natural resources must have a high priority on our national agenda. But given sound research, innovative technology, hard work, sufficient public and private funds, and--most important of all--the necessary political will, we can achieve and maintain the environment that protects the public health and enhances the quality of life for us all." *President George Bush*, "Building a Better America," February 9, 1989. This document also gave three principles as the basis for the Initiative, as follows:

"The President is committed to protecting the Nation's groundwater resources from contamination by fertilizers and pesticides without jeopardizing the economic vitality of U.S. agriculture.

"Water quality programs must accommodate both the immediate need to halt contamination and the future need to alter fundamental farm production practices.

"Ultimately farmers must be responsible for changing production practices to avoid contaminating ground and surface waters. Federal and state resources can provide valuable information and technical assistance to producers so that environmentally sensitive techniques can be implemented at minimum cost."

### WATER QUALITY RESEARCH OBJECTIVES

The objectives are from two sources.

USDA Research Plan for Water Quality, January, 1989

1. Document the sources and amounts of potentially hazardous contaminants in groundwater which are attributable to current agricultural and forestry practices, and identify the basic processes involved in their movement through soil and into groundwater.
2. Develop new field and laboratory methods for rapidly, reliably, and inexpensively analyzing pesticide residues and for determining the rates at which water and chemicals move through soils to groundwater.
3. Develop new and modified crop and livestock production systems that substantially decrease the movement of potentially hazardous chemicals into groundwater, and determine the effects of these new systems on farm costs, changes in farm inputs, and production choices.
4. Develop simple, inexpensive, on-farm methods for disposing of pesticide containers and other hazardous wastes without contaminating groundwater.
5. Develop decision-aid systems that may be used by technical and farm management specialists, Extension agents, and farm consultants to help individual farmers select, apply, and manage profitable and environmentally sound crop and livestock production practices.
6. Evaluate economic, social, and political impacts of alternative crop and livestock production systems, policies, and institutional strategies to control groundwater contamination.

USDA Water Quality Initiative 1992 Work Plan

1. To improve and expand our knowledge of agricultural practices related to water quality.
2. To integrate that knowledge into production management systems that use economically and environmentally sound practices.

Program evaluation, to be accomplished through reporting and planning conferences, was specified in the USDA Research Plan for Water Quality (1989), the Water Quality Program Plan to support the Initiative (1989), and the USDA Water Quality Initiative Work Plans for 1990, 1991, and 1992.

All projects supported by initiative funding are considered as a total program of interrelated water quality research. The U.S. Department of Agriculture (USDA) Research Plan for Water Quality (1989) set up a structure with two general types of research activities. One type designated as Priority Components research includes a wide range from fundamental laboratory and field research to applied types of technology-driven studies, concentrating on parts or "components" of processes, practices, or systems. The other type in the 1989 Plan, Selected Geographic Systems, is represented by the long term Management Systems Evaluation Areas (MSEA) begun in 1990. This research focuses on developing and evaluating agricultural production systems for corn and soybean production areas, and is comprised of feasible combinations of results from components research, other relevant studies, and practical experience.

There are two reports resulting from the 1992 evaluation and planning sessions for the South and West Regions held at Baton Rouge, Louisiana and Tucson, Arizona, respectively. Also, a separate summary of accomplishments is available. Abstracts of the past year's research results for all new and continuing Water Quality Initiative projects funded by ARS and CSRS are included in the Appendix. All of this information was considered in the evaluation of progress and the research needs and priorities given in this report.

## PRIORITY COMPONENTS

### INTRODUCTION

The water quality research program review and evaluation of accomplishments and needs, funded as USDA grants and awards under the President's Initiative, was participated in by federal, university, industry, and independent scientists, 6 evaluators at each location, several observers, and speakers. There was a total of 159 projects of the Agricultural Research Service (ARS), Cooperative State Research Service (CSRS) and State Agricultural Experiment Stations (SAES), and collaborators, that constituted the accelerated and new water quality program being evaluated. In addition to these agricultural research organizations, participation included the Extension Service (ES), Soil Conservation Service (SCS), U.S. Geological Survey (USGS), the fertilizer and agricultural chemicals industries, and the private sector. Additional participants were invited.

### EVALUATION and WORKSHOP OBJECTIVES

**Exchange scientific and technical information** among principal investigators, other researchers, program managers, and users of information.
**Evaluate progress, collaboration, and coordination** in USDA-funded research programs.
**Identify significant results** and new developing opportunities for collaboration with related programs.
**Identify promising agricultural production** and management systems and technologies.

## PLAN and PROCESS

States in the Southern and Western Regions were involved in the April 21 to 23, and April 28 to 30, 1992 evaluation and review conference at Baton Rouge and Tucson, respectively. Principal investigators of all projects receiving Initiative funding in FY 1990 and 1991, and ongoing projects from FY 1989, were requested to prepare an abstract and report of progress, display and discuss a poster of research results and future plans, and participate in a work group(s). They discussed accomplishments and cooperatively developed priorities for problems still needing solutions, considering the goals and objectives of the Initiative. In addition, scientists in the North Central and Northeast Regions who received Initiative funds also prepared abstracts and progress reports. All abstracts were available for the 1992 meetings. They appear in the appendices of the comprehensive reports; titles and investigator names are in the appendix of the Summary report.

The scientists at the two workshops were organized into general Research Problem Area (RPA) work groups to reflect their interests and expertise, including: Chemical Fate and Transport; Transformation and Remediation--Pesticides, other Organics and Microbes; Nitrogen, other Nutrients, Wastes, and Metals; Production Management Systems; Social Sciences; Education and Technology Transfer. The last two groups interacted with each of the other four RPAs. The Education and Technology Transfer group included "users" of information representing ES, SCS, the private sector, industry, and several participants from other panels. Recommendations by the workshop panels will be utilized by CSRS and ARS in setting priorities for funding water quality projects in FY 1993 and later years.

An Evaluation Panel composed of an expert in each RPA was selected from outside the region being evaluated, except for the Social Sciences RPA in the South and the panel leaders for Education and Technology Transfer. The evaluation panelists were responsible for reviewing abstracts and reports by the scientists and other materials prepared for the meetings, and for the preparation of a report given at the beginning of the meeting. This served as the baseline for scientist debates within the individual workshops. The evaluation panelists prepared reports of the deliberations and conclusions of their respective workshops. These became the individual RPA reports.

### Evaluation Panel and Work Group Guidelines

The evaluation included examining several aspects of the development of the research, whether it addresses appropriate problems in water quality, progress of the overall program, interactions with others, usefulness of results, and other points. The following guidelines were presented.

**Appropriate development** of program objectives and plans,
Use of the most **technically advanced methods** in research,
**Interdisciplinary, inter-site, and inter-agency coordination** where appropriate,
**Adequacy of results** to determine if water quality can be protected/enhanced, and how to do it,
**Transferability of results** or methodologies to--
- Education and technical assistance agencies, consultants, and farmers,
- Other areas and regions of the country, and
- Other management conditions in time and space.

**Identify research needs and opportunities** that need a different emphasis to facilitate meeting program objectives, and
**Suggest changes of emphasis** to meet the needs.

## EVALUATION and WORKSHOP RESULTS

The Initiative program has funded excellent research at a number of Land Grant Universities, ARS laboratories, and private foundations. The principal investigators are well qualified, the overall quality of research is high, and the projects address a broad range of problems from both a subject matter and geographic viewpoint. The investigators are using "cutting edge" analytical and experimental methods. Numerous projects have made advances that can have an immediate impact on enhancing groundwater quality.

The scientists' reports for the program evaluation were based on only 6 to 24 months of results from 2- or 3-year projects funded by the President's Initiative on Water Quality. Movement and degradation of pesticides is usually a long-term problem, the solution of which requires an investment in long-term research activities. The research reported here utilized fundamental and applied methods to learn about the behavior of pesticides in soil and water. Emphasis was on widely used chemicals or ones having been detected in groundwater.

Details of work group actions are given in reports of the South and West. They contain program evaluation information and recommendations of research needs that may require special attention. Also, certain problem areas are recommended for increased emphasis to reflect the impact of research already underway. Conversely, some types of research have sufficient results to justify a redirection of emphasis.

## STATE OF COMPONENTS RESEARCH

**INFORMATION CONTAINED IN THIS REPORT IS CONSIDERED PRELIMINARY AND THE PRINCIPAL INVESTIGATORS SHOULD BE CONTACTED FOR DETAILS AS TO INTERPRETATION AND USE.**

The processes by which chemicals used in agriculture reach surface and groundwater range in space and time from microscopic to fields and watersheds and from seconds to days and decades. Studies of these orders of magnitude require a well conceived and long-term research program. The USDA research awards have contributed to progress in solution of a broad range of problems. Much of the emphasis has been on those where short-term research was expected to yield good information.

One of the most significant accomplishments of the Water Quality Initiative is graduate student and post doctoral training. This is emphasized in several of the work groups as being an important spinoff that generates intensely trained students in broadly diverse areas--all very important to our concerns about protecting and maintaining quality of our natural resources.

To aid in understanding the technology transfer (TT) concept and to convey a classification of accomplishments from the research being evaluated, the results given under each RPA were classified as to phase of technology transfer. We have used the phase designations and explanations given by R. S. Rauschkolb[1], panel member for TT at the Tucson meetings. "Technology transfer occurs along a continuum of development and application from the initial concept of the hypothesis to final application and adoption by the practitioner. Even the most basic scientist is a benefactor of technology transfer." The status of accomplishments is identified by TT-phase to more readily assess the contribution of the accomplishments toward some perceived solution to a problem. The term technology is used in a broad sense to include information and knowledge transfer to scientists, specialists, producers, policy makers, and others.

Phase 1. Results of research are ready for sharing with the scientific community and are presented for verification of the principle, methodology or technique.

Phase 2. Results are ready for development and adaptive research through field validation in collaboration with scientific colleagues in Extension, Industry, SCS, *et al.* The principle is being adapted and used under a wide range of conditions in order to collect the data required to conduct an educational program to facilitate adoption in phase 3.

Phase 3. The practices, methods, or techniques are ready for widespread implementation and commercial adoption.

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[1] Rauschkolb, R. S.,and L. W. Dewhirst. 1991 Technology Transfer: A University Perspective. p. 167-184. *In* V. J. Rhodes (ed.) Agricultural Sciences Policy in Transition. Agricultural Research Institute Publ., Bethesda, MD.

Fortunately, proposals were conceived that built upon accomplishments of earlier relevant research, and extended ongoing projects where additional funding would produce quicker or more useful results. *The Initiative program has facilitated integration of results into products for immediate application as well as a more focused assessment of remaining problems.*

Within each RPA under the subsection titled "State of Current Research", some products of the individual research projects funded by ARS and CSRS are given. The technology transfer phase (TT-_) classification and the state(s) where research was done are given for each product or accomplishment. The TT phase establishes the listing order for the accomplishments, with phase 1 given first. Where two numbers are given, the results are at different stages of development for conditions of climate, soils, chemicals, etc., which affect those results or the adoption of them.

## CHEMICAL FATE AND TRANSPORT

Fate and transport processes to which chemicals are exposed as they travel from the soil surface to groundwater are imbedded in nearly all projects funded under the Initiative. Understanding these processes is necessary for correct interpretation and solution of nonpoint pollution problems The research from which these accomplishments were derived is high in quality and is addressing the Initiative objectives. Some of the accomplishments of research in these regions are given, along with the TT phase classification of each.

### SOUTH REGION

**Preferential (by-pass) flow** as related to soil properties was incorporated into water and chemical transport models, making them more realistic in use. (AR, KY, SC) [TT-1]

**Hydrologic characteristics of soils** are criteria for a classification system to identify soils and landscape units most vulnerable to groundwater contamination. (AR, KY, SC) [TT-1]

**Chemical transport through substrata** of saprolite and partly weathered rock can determine site suitability for disposal of household wastewater in rural areas. (NC) [TT-1]

**Water quality of Karst topography systems** is being measured over time to help determine if chemicals in spring water entered the flow system from a sinkhole. (KY) [TT-1]

**Strategies for application of manure and poultry litter** include volatilization, runoff, plant use, and leaching, integrated to minimize water contamination. (AR) [TT-2]

**A nutrient transport component for N and P** has been added to the GLEAMS model to expand its usefulness for management of fertilizer and manure applications. (GA) [TT-2]

**Water quality of loess soils** along the Mississippi river was enhanced by adoption of no-till practices and winter cover crops, contradictory to some other results. (TN) [TT-2]

**Riparian zones and vegetated buffers** reduced chemicals in surface and groundwater leaving watersheds where animal production facilities were concentrated. (GA) [TT-2]

**Water table management** by controlled tile drainage reduced surface runoff 50%, N and P losses by 30%, and pesticide losses by 50%. When combined with fertilizer and pesticide BMPs, aldicarb loss was further reduced by a factor of two. (NC, LA) [TT-3]

The USGS model US2DT was modified and tested. It predicts fate of N and pesticides when tile drainage is used for control of the water table. (NC) [TT-3]

### WEST REGION

**The retardation coefficient of the herbicide Prometryn** appears smaller for initially moist soil conditions compared to initially dry conditions at application, and lower rates may be used with chemigation as compared with standard irrigation treatments. (AZ) [TT-1]

**Time domain reflectrometry (TDR)** is a rapid and inexpensive technique for monitor solute travel time in the upper 0.5m (20in) of clay loam soils. (CA) [TT-1]

**Point samplers installed in the groundwater-vadose zone** can be used for inexpensive monitoring of water quality resulting from using BMPs on coarse-textured soils. (CO) [TT-1]

**Several data bases useful** for validating computer models are available to other investigators. This will multiply the utility of carefully collected field data. (AZ, CA, MT) [TT-1]

**Movement of quickly degraded, non-volatile chemicals can be reduced** by allowing more time for degradation in the soil surface prior to irrigation events. (MT) [TT-2]

**Two inexpensive capillary wick samplers** were developed for farmers and researchers to measure water and chemical movement in the vadose (unsaturated) zone. (OR) [TT-2]

**New software packages and manuals for solute transport** models: [All are TT-2, 3]

HYDRUS predicts solute and water transport below the root zone in salt-affected soils, and considers root uptake as a function of water and salinity stresses. (CA)

SWMS-2D was developed to portray 2-D transport of water and solutes in cropped soils. (CA)

MESH--users can display water retention curves and hydraulic conductivity curves estimated from soil survey data including texture, bulk density, organic matter, soil structure. (HI)

TETRANS--250 copies of an updated solute transport package developed for Macintosh and IBM-compatible computers have been distributed to users. (CA)

**Assistance was provided to four agencies** in using a mobile, non-evasive, high speed salinity mapping technology in their water quality protection programs. (CA) [TT-3]

**Training of graduate and post-doctoral students** has occurred at those universities funded through this program resulting in the development of human resources trained in water quality.

## TRANSFORMATION AND REMEDIATION
## Pesticides, Other Organics, Microbes

The currently-funded research is well-focused and of excellent quality, although the number of projects is low. All are making significant progress toward achieving their objectives. Although we can anticipate useful accomplishments in the assessment of transformation processes, in the remediation of contaminated soil and water, and in preventative management practices that minimize contamination potential, continued support and additional effort in biotransformation and bioremediation is greatly needed. Transformation processes should be included as key components of any model which simulates the fate process or aids in making management decisions for remediation in maintenance of soil and water quality.

### SOUTH REGION

**Subsurface drain water** from sugarcane fields, containing high concentrations of atrazine, was removed experimentally at certain periods--a procedure that could reduce risk. (LA) [TT-1]

**Inexpensive adsorbents for pesticide** sprayer rinsate and waste solutions quickly reduce chemical concentration. Practical disposal methods are under study. ( AR, VA) [TT-1,2]

**Minimal leaching to groundwater** occurred under normal agricultural practices for fenamiphos and fluometuron due to rapid degradation and sorption. (FL, MS) [TT-2]

**Ultra-low-volume herbicides and sensor sprayers** reduce amounts of herbicide needed to control weeds. ULV reduced postemergence herbicides by a factor of 10. (MS) [TT-2, 3]

### WEST REGION

**New molecular methods were developed** for use in groundwater to detect bacterial pathogens such as *Salmonella* and *Shigella* , as well as viral pathogens including poliovirus. (AZ) [TT-1]

**The potential use of genetically engineered microorganisms** in the remediation of chloroaromatics has been successfully demonstrated. (ID) [TT-1]

**A practical and effective method to remove excess selenium** from agricultural drainage water uses specifically isolated bacteria. (CA) [TT-2]

**On-site detoxication of sprayer rinsates and empty containers** uses immobilized microbial cells to eliminate hazardous point sources of pesticides. (ID) [TT-2]

**Chemical transport and persistence** were evaluated in no-till and conventional furrow-irrigated management systems. (NM) [TT-2]

**Timing of irrigation after herbicide application** minimized dicamba and 2,4-D transport through the root zone. Delayed water application allowed degradation in the surface soil. (MT) [TT-3]

All projects related well to the objectives, and investigated reduction of nitrate flow from agricultural lands to groundwater or nitrate and phosphate flow to surface water. In many instances, funds through this Initiative bought into major ongoing research projects relating agricultural activities to possible contamination of water. This leveraging has resulted in more comprehensive accomplishments than would have been possible otherwise. The abstracts, reports, and posters were excellent and showed that work was integrated with other RPAs, in particular fate and transport. This emphasized the interaction of water, nutrients, and pesticide movement, very important in both regions with great diversity from very low to high rainfall, and including irrigation. The excellent research in this program has resulted in release of much useful information.

## SOUTH REGION

**Heavy applications of poultry, dairy, and swine waste** can produce nitrate levels well over 100 mg N/liter (ppm) in groundwater. Research has shown BMPs can control nitrate losses, but adoption by producers is slow. (AR, VA, GA) [TT-1, 2]

P **build-up in surface soils** from heavy rates of animal waste caused loss of soluble and bioavailable P into surface waters. (AR, confirmed by VA, GA) [TT-1, 2]

**Soil nitrate tests** to improve N fertilizer recommendations are having limited success in humid areas, but nitrate testing is well established in drier areas of the Great Plains and the West. (VA) [TT-1], (OK, TX) [TT-2, 3]

**Improved N use efficiency** for irrigated and dryland crops resulted from split N-applications. Fertigation (N in irrigation water) maintained production with less fertilizer. (GA) [TT-2]

**N and P runoff losses in drier areas** of Oklahoma were decreased with cover crops, but runoff losses of soluble P and bioavailable P sometimes increased. (OK) [TT-2]

**Water table management reduced loss of nitrate** when water tables were kept high as compared to freely drained treatments. (NC, SC) [TT-2, 3]

**Residual nitrate in soils and water was reduced effectively** by using canola, oats or forage turnips as non growing-season cover crops. (GA) [TT-3]

**Animal waste drained into playas** for more than 20 years showed less than 3 mg N/kg (ppm) nitrate deeper than one meter. The playas function well in containing nitrate. (TX, OK) [TT-3]

## WEST REGION

**Diagnostic technology for fingerprinting dissolved carbon**, and for quantifying water movement and plant nitrogen stress have been developed. (AZ, CA, CO, OR) [TT-1]

**Reduced leaching-fraction irrigation and drainage management** can improve the quality of both surface and groundwater resulting from irrigated agriculture. (CA, UT) [TT-2]

**An optimization model** has been developed for irrigation scheduling. (UT) [TT-1, 2]

**A calcium carbide nitrification inhibitor**, extensively tested around the world, is effective for decreasing nitrate leaching potential in a broad range of soils . (CO) [TT-2]

**Hardware and software have been released** for irrigated agriculture using mobile salinity sensors to assess salinity, nitrate, and water movement. (CA) [TT-2, 3]

**Simulation models** have been released. (CA, CO, UT)

SOWACH--Programs to estimate salt movement, and a user's manual, can be obtained from the Utah Agricultural Experiment Station, Logan, UT. [TT-2]

TETRANS--The model to estimate trace element and salt movement can be obtained from the U.S. Salinity Laboratory, Riverside, CA. [TT-2]

NLEAP--The N application and leaching model has been delivered to SCS, personnel are being trained in its use, and it is published in a Soil Science Society of America book, "Managing Nitrogen for Groundwater Quality and Farm Profitability", Madison, WI. [TT-3]

## PRODUCTION MANAGEMENT SYSTEMS

Concerns are to develop measures to reduce sources of potential pollutants of water including cultural management, predictive techniques, and to facilitate management decisions on field, farm, and watershed scales. Several noteworthy accomplishments resulting from well focused research were identified and are listed below.

### SOUTH REGION

**Animal waste and plant nutrient components,** forest management, and application to risk assessment for pesticide registration decisions have been incorporated into the GLEAMS model. Model maintenance and user support is provided. (GA) [TT-1]

**A mature forest buffer** reduced sediments in runoff water and nitrate by plant uptake and denitrification. A restored forest buffer was not as effective the first year. (GA) [TT-1, 2]

**EPIC and SWRRB models were modified.** A manure land disposal component was added to EPIC, and both were changed to meet SCS needs for water quality assessment. (TX) [TT-2]

**A computer software system to estimate pesticide leaching and degradation** compares fate of chemicals, or a single chemical in different management. It is useful for farm level decision-making and watershed, county, and state policy-making guidelines. (FL, OK) [TT-2]

**Peanut pest control is effective,** economical, and environmentally sound with a knowledge-based computerized system to identify pesticides for peanuts. (FL, NC, OK) [TT-2]

**Remotely sensed data on crop types was** integrated into a geographical information system (GIS) and linked to models to estimate large area groundwater pollution potential, thus increasing accuracy. (NC) [TT-2]

**Grass filters effectively intercepted** sediment, nitrate, and atrazine during runoff from a 2.5 in/hr rainfall over 2 hours. (KY) [TT-2, 3]

**Vegetated filters intercepted sediment, P, and nitrate** between agricultural fields and small streams to cost effectively improve surface and groundwater quality. (NC, VA) [TT-3]

### WEST REGION

**Root Zone Water Quality Model (RZWQM) incorporates preferential flow,** thus it will aid in understanding chemical movement through the soil profile. (CO) [TT-1]

**Scheduling of herbicides based on weed population data** reduced spray rates by 10 to 15%, while increasing net returns from the crop production system. (CO) [TT-1,2]

**Prescription farming** matches fertilizer use to crop needs in different soils in a field. Profits increase and potential for nutrient loss is reduced. (MT, MN, ME, WA) [TT-1, 2, 3]

**A method to identify nitrate leaching hot spots,** using the NLEAP model and GIS technology is being field tested in the Northern Colorado Water Conservancy District. (CO) [TT-2]

**An "expert system" for advising producers** on rates of N for irrigated corn ensures adequate N for the crop without an excess that can leach to groundwater. (CO) [TT-2]

**Alternative management practices on farmland can be ranked** and weights placed on model outputs such as ground and surface water quality, nutrient leaching, and net income, thus replacing subjective decision making with objective criteria. (AZ) [TT-2]

**Contaminant source in well water can be screened** to allow one to deduce if it originates from a point or non point source, using special pumping procedures. (AZ) [TT-2]

**High irrigation water use efficiency** reduced or eliminated groundwater pollution by potentially hazardous agricultural chemicals and salts. (CO, UT) [TT-2,3]

## SOCIAL SCIENCES

The current social science research is of good quality, but is not adequate to provide the information needed for farm, state or national level decisions. Significant efforts are underway which address farm level consequences of alternative practices, and the importance of incentives as a method of implementing a more environmentally sensitive agriculture. Despite the limited scope of the present program, social science projects have produced several important accomplishments some of which are available to integrate into decision aids.

### SOUTH REGION

**Integration of GIS into socioeconomic analysis** of water quality issues offers a unique perspective on the social and private water quality improvement decision process. (AR, LA) [TT-1]

**Tradeoffs between regional farm income** and management of poultry litter to prevent nitrate contamination showed that restricting application rates reduced production and income. Researchers are linking the economic model and GIS to a soil/solute transport model to examine relations between income and nitrate losses. (AR) [TT-1,2]

**Integration of physical and natural science research with economic analysis** was accomplished through effective interdisciplinary research. (FL, NC, OK) [TT-1,2]

### WEST REGION

**There may be important tradeoffs** between nitrate leaching and other environmental objectives, such as sedimentation and erosion. (OR, WA) [TT-2]

**Water quality can be improved in some areas** by facilitating the voluntary transfer of water rights to urban use through water markets. (UT) [TT-2]

**Four factors explain much variability** in the level of nitrogen contamination of water wells in dryland cropping systems in the Northern Great Plains: soil type, land use, potential evapotranspiration, and slope. (MT) [TT-2]

**Producers can simultaneously reduce nitrate leaching and improve farm income** on many sprinkler and furrow irrigated farms of the Pacific Northwest. (OR, WA) [TT-3]

**The most cost effective method of reducing nitrate leaching** in the surface water (flood irrigation) areas of the Pacific Northwest appears to be reduced water applications. (OR, WA) [TT-3]

**Production cost incentives** induce rapid adoption of environmentally sensitive technologies if combined with education and technical assistance. (CA, RI, DC) [TT-3]

## EDUCATION AND TECHNOLOGY TRANSFER

Scientists and specialists representing agricultural experiment stations and cooperative extension services of the Land Grant Universities, ES, ARS, SCS, and Office of The Secretary-USDA, the Corn Belt MSEA Project, and private industry met to discuss and evaluate USDA sponsored research funded by the President's Water Quality Initiative. There has been considerable effort thus far to initiate investigations which have potential payoff through application of results. The research is addressing major problems, is on target in terms of program goals and objectives, and some projects are already producing results now being used by farmers in reducing the potential to adversely affect ground and surface water quality. Some results are ready for widespread adoption. These and others need adaptive research along with delivery to producers.

## SOUTH REGION

**Vegetated buffer strips.**
**Water table management.**
**Application of GIS systems** to water quality issues, particularly for technology transfer.
**Computer models and decision-making aids** are already incorporated into resource and farm planning by SCS.
**Solute movement through the root zone by preferential flow is very important** in many soils, according to research results. In these soils, an often used concept of uniform or piston flow-based models will not provide accurate simulation for predicting flow and solute movement. The potential impact on accuracy of using most models is great.
**Technologies for disposal/remediation of rinsate** waters that are both environmentally sound and legally achievable.
**Projects addressing specific crops to directly address** problems of nutrient loadings and losses.
**Animal (poultry) waste and wheat fertilization projects** address water quality problems head-on.

Priorities from Existing Data

**Compile a Southern Region research bulletin** documenting what is known about nutrient release rates from animal and plant residues in different soil/environmental areas. CSRS and ARS should take the lead so a reference of "standardized" release coefficients is available in the near future. This information is critically needed now for P release coefficients.
**Develop a "background" paper on soil P** and how management of high soil P levels can preclude detriment of water quality.

## WEST REGION

An important effect of the program is the **training of graduate and post-doctoral students** at those universities funded through this program. Critically needed human resources technically trained in water quality are very important for TT agencies and industry, as well as for research.

Examples of accomplishments were classified by the panels as ready for use by TT agencies and/or adaptive on-farm trials for site specific modifications.

**New software packages and manuals for several solute transport** models. [TT-2, 3]
**A mobile, high speed salinity mapping** technology is being used by 4 agencies in their water quality protection programs. [TT-3]
**Hardware and software have been released** for subsurface drip irrigation with sensors to assess salinity, nitrate, and water movement. [TT-2, 3]
**Delayed irrigation after herbicide application** minimized dicamba and 2,4-D transport. Time allowed degradation in the surface soil. [TT-3]
**Prescription farming can** increase efficient use of nutrients. By matching fertilizer use to crop requirements for different soils in a field, the potential for nutrient leaching to groundwater is greatly reduced. This practice is being used successfully. [TT-1, 2, 3]
**High irrigation water use efficiency** reduced groundwater pollution by potentially hazardous agricultural chemicals and salts. Every inch of excess irrigation water on corn can result in about 10 lb/a of N leached. [TT-2,3]

# APPENDIX

## THE PRESIDENTS INITIATIVE on WATER QUALITY
## Titles of Research Projects
## 1992 Report

The following are titles of research projects funded in part by ARS and CSRS, through the USDA Water Quality Program of the Presidents Initiative on Water Quality. The abstracts are in the Appendixes of the comprehensive report. These additional projects to ongoing research are producing very useful information for improved management of potential pollutants from agriculture.

ARIZONA FARMSTEAD CONTAMINATION OF GROUNDWATER. H. Bouwer, A. J. Clemmens, USDA-ARS, Phoenix, AZ; T. Maddock, University of Arizona. Report Period: 8/91 - 2/92.
ARIZONA NITROGEN FERTILIZER AND WATER TRANSPORT UNDER 100% IRRIGATION EFFICIENCY. H. Bouwer, F. J. Adamsen, D. J. Hunsaker, R. C. Rice, and F. S. Nakayama, USDA-ARS, Phoenix, AZ. Report Period: 2/91 - 2/92.
ARIZONA NONIDEAL TRANSPORT OF PESTICIDES IN SOILS. M. L. Brusseau, University of Arizona. Report Period: 9/1/91 - 2/1/92.
ARIZONA DEVELOPMENT OF A PROTOTYPE DECISION SUPPORT SYSTEM FOR WATER QUALITY MODELS. L. J. Lane, D. S. Yakowitz, USDA-ARS; J. J. Stone, P. Heilman, B. Imam, University of
ARIZONA MOLECULAR METHODS FOR EVALUATION OF MICROBIAL QUALITY OF GROUNDWATER. I. L. Pepper, C. P. Gerba, S. D. Pillai, University of Arizona. Report Period: 7/1/90 - 2/20/92.
ARIZONA MANAGEMENT PRACTICES AND PREFERENTIAL FLOW TRANSPORT OF AGRICULTURAL CHEMICALS. A. W. Warrick, John E. Watson, Jon P. Chernicky, David O. Lomen, University of Arizona. Report Period: 6/89 - 12/91.
ARIZONA THE PERSISTENCE OF PREFERENTIAL FLOW DURING AN INFILTRATION EVENT. A. W. Warrick, John E. Watson, Janick Artiola, Jon P. Chernicky, University of Arizona. Report Period: 7/91 - 2/92.

ARKANSAS & TEXAS MODELING WATER QUALITY IMPACTS OF SURFACE-APPLIED BROILER LITTER TO IDENTIFY BMPs. T. C. Daniel, D. R. Edwards, University of Arkansas, and R. H. Griggs, Texas A&M University. Report Period: 7/90 - 3/92.
ARKANSAS OPTIMIZING ON-FARM DISPOSAL OF PESTICIDE RINSATES. T. L. Lavy, J. D. Mattice, D. C. Wolf, R. E. Talbert, University of Arkansas. Report Period: 9/89 - 2/92.
ARKANSAS DEVELOPMENT OF A GEOGRAPHIC INFORMATION SYSTEM TO ANALYZE NITRATE CONTAMINATION FROM THE LAND APPLICATION OF POULTRY LITTER. H. D. Scott, M. J. Cochran and W. F. Limp. University of Arkansas. Report Period: 9/89 - 2/92.

CALIFORNIA WATER QUALITY MANAGEMENT ON THE WESTSIDE SAN JOAQUIN VALLEY. J. E. Ayars, C. J. Phene, H. I. Nightingale, G. S. Banuelos USDA-ARS, Fresno, CA. Report Period: 12/90 - 2/92.
CALIFORNIA DISSOLVED ORGANIC MATTER IN SOIL AND NATURAL SYSTEMS AND ITS ROLE IN GROUNDWATER POLLUTION. A. C. Chang, Z. R. Hinedi, and R. W. K. Lee, University of California, Riverside. Report Period: 7/90 - 2/92.
CALIFORNIA ASSESSMENT OF SOIL SALINITY AND SALT-LOADING TO GROUNDWATER. D. L. Corwin, J. D. Rhoades, S. Lesch, P. J. Vaughan. Report Period: 1/91 - 2/92.
CALIFORNIA A WATER DESELENIFICATION PROCESS USING ACCELERATED MICROBIAL VOLATILIZATION. W. T. Frankenberger, Jr., University of California, Riverside. Report Period: 6/90 - 4/91.
CALIFORNIA COMPARISON OF TRANSFER FUNCTION AND MECHANISTIC FLOW AND TRANSPORT MODELS. W. A. Jury, Z. J. Kabala, S. R. Yates, University of California, Riverside. Report Period: 7/91 - 2/92.
CALIFORNIA FIELD TEST OF A STOCHASTIC, ORGANIC SOLUTE, TRANSPORT MODEL. D. Rolston, L. Kavvas, J. Biggar, K. Scow and B. Hammock, Univ of California, Davis. Rpt Period: 7/90 - 3/92.

CALIFORNIA WATER QUALITY MODELS FOR IRRIGATED SALT-AFFECTED SOILS. M. Th. van Genuchten, J. D. Rhoades, S. R. Yates, D. L. Corwin, and W. F. Spencer, U. S. Salinity Laboratory, USDA-ARS, Riverside. Report Period: 5/90 - 2/92.
CALIFORNIA, RHODE ISLAND & WASHINGTON DC ECONOMIC INCENTIVES TO REDUCE AGRICULTURAL POLLUTION. J. E. Wilen, C. L. Kling, University of California, Davis, D. Wichelns, University of Rhode Island, M. Weinberg, USDA-ERS, Washington, D.C. (former graduate student, UC Davis). Report Period: 6/90 - 2/92.

COLORADO ROOT ZONE WATER AND CHEMICAL TRANSPORT AS ALTERED BY FLOW PATHS, CROP ROOTING, AND MANAGEMENT. L. R. Ahuja, J. G. Benjamin, USDA-ARS, Fort Collins. Report Period: 4/91 - 2/92.
COLORADO EFFECT OF BEST MANAGEMENT PRACTICES ON GROUNDWATER QUALITY. D. S. Durnford, J. C. Loftis, L. R. Walker, Colorado State University. Report Period: 6/91 - 2/92.
COLORADO WATER AND NITROGEN MANAGEMENT TO PROTECT GROUND-WATER QUALITY. R. F. Follett, M. J. Shaffer, L. K. Porter, A. R. Mosier, all USDA-ARS. Report Period: 1/90 - 2/92.
COLORADO WATER AND NITROGEN MANAGEMENT TO PROTECT GROUND WATER QUALITY. D. F. Heermann, R. F. Follett, M. Shaffer, H. R. Duke, E. E. Schweizer, USDA-ARS, Ft. Collins, CO. Report Period: 2/91 - 2/92.
COLORADO & UTAH CROP MANAGEMENT KNOWLEDGE BASED SYSTEM FOR REDUCING GROUNDWATER CONTAMINATION. J. Loftis, I. Broner, P. Soltanpour, K. Thompson, Colorado State University, and R. Peralta, R. H. Hanks, Utah State University. Report Period: 6/90 - 2/92.
COLORADO PREDICTING PESTICIDE LEACHING FROM SPATIAL VARIABILITY OF TRANSPORT PROPERTIES. J. C. Loftis, D. B. McWhorter, G. Butters, D. S. Durnford, Colorado State University, and H. R. Duke, R. F. Smith, USDA-ARS, Fort Collins, CO. Report Period: 6/90 - 2/92.

CONNECTICUT PREFERENTIAL FLOW OF ATRAZINE IN BANDED AND BROADCAST TREATMENTS IN CORN. K. Guillard, G. S. Warner, K. Hatfield, J. Stake, University of Connecticut. Report Period: 6/91 - 2/92.
CONNECTICUT DEGRADATION OF PESTICIDE WASTES AND CONTAMINATED MEDIA. J. J. Pignatello. Report Period: 7/90 - 1/92.

DELAWARE & MARYLAND NITRATE LEACHING FROM SOYBEANS AND SUBSEQUENT CONTAMINATION OF GROUNDWATER. J. J. Fuhrmann, B. L. Vasilas, University of Delaware, and J. S. Angle, University of Maryland. Report Period: 7/90 - 2/92.
DELAWARE LEACHING, SORPTION AND BIODEGRADATION OF HERBICIDES IN SUBSOILS OF A COASTAL PLAIN WATERSHED. J. T. Sims, J. J. Fuhrmann, and D. L. Sparks, University of Delaware, Newark. Report Period: 9/89 - 2/92.

FLORIDA DEGRADATION OF TELONE II AND FENAMIPHOS IN SUBSOILS AND GROUNDWATER, AND BY MICROORGANISMS. L. -T. Ou, University of Florida. Report Period: 7/90 - 2/92.

GEORGIA CHEMIGATION IMPACTS ON WATER, SOIL, AND CROP QUALITY. J. E. Hook, J. G. Davis-Carter, and G. J. Gascho, University of Georgia and R. D. Wauchope, C. C. Dowler, A. W. Johnson, USDA-ARS, Tifton, GA. Report Period: 5/91 - 2/92.
GEORGIA WINTER COVER CROPS IN REDUCTION OF $NO_3$ LEACHING. J. W. Johnson, W. L. Hargrove, P. L. Raymer, University of Georgia, Tifton and J. E. Box, Jr. USDA-ARS, Watkinsville, GA. Report Period: 6/90 - 2/92.
GEORGIA AGRICHEMICAL TRANSPORT AND CONTROLLING PROCESSES IN THE CLAIBORNE AQUIFER RECHARGE AREA OF SOUTHWEST GEORGIA. R. A. Leonard, D. D. Bosch, and C. C. Truman, USDA-ARS, Tifton, Georgia. Report Period: 2/91 - 2/92.
GEORGIA DEVELOP DECISION AIDS AND OTHER MODEL-BASED SYSTEMS FOR ENHANCING WATER QUALITY AND FARM PROFITABILITY. R. A. Leonard, D. D. Bosch, C. C. Truman, USDA-ARS, Tifton, Georgia. Report Period: 1/90-2/92.

GEORGIA USE OF A RE-ESTABLISHED RIPARIAN FOREST TO CONTROL WATER POLLUTION FROM A MANURE APPLICATION SITE. R. Lowrance, R. K. Hubbard, USDA-ARS, Tifton, Georgia. Report Period: 2/91 - 2/92.

HAWAII APPLICATION OF FRACTAL GEOMETRY FOR ESTIMATING SOIL HYDRAULIC PARAMETERS. H. Chang, G. Uehara, G. Y. Tsuji, University of Hawaii. Report Period: 7/90 - 2/92.

IDAHO MICROBIAL DETOXIFICATION OF PESTICIDE CONTAINERS AND RINSEATES. R. L. Crawford, D. L. Thill, H. W. Homan, University of Idaho. Report Period: 7/90 - 2/92.
IDAHO APPLICATION OF GENETICALLY ENGINEERED MICROORGANISMS IN REMEDIATION OF CHLOROAROMATICS. C. S. Orser and R. L. Crawford, Univ of Idaho. Report Period: 8/91 - 2/92.

ILLINOIS HERBICIDE DISSIPATION AND WEED CONTROL MODELS FOR REDUCING HERBICIDE CONTAMINATION OF GROUNDWATER. M. G. Huck, L. M. Wax, USDA-ARS, Urbana, Illinois. Report Period: 4/90 - 2/92.
ILLINOIS & OHIO WATER FLOW AND HERBICIDE TRANSPORT THROUGH SOIL MACROPORES. F. W. Simmons, C. W. Boast, Univ. of Illinois and E. L. McCoy, The Ohio State University. Report Period: 8/90 - 3/92.
ILLINOIS & NORTH DAKOTA EVALUATION OF NATURAL ABUNDANCE 15N TECHNIQUES FOR GROUNDWATER NITRATE STUDIES. R. M. Vanden Heuvel, R. L. Mulvaney, Univ. of Illinois; L. Prunty, B. R. Montgomery, North Dakota State University. Report Period: 5/89 - 3/92.
ILLINOIS WEED MANAGEMENT AND APPLICATION TECHNIQUES FOR GROUNDWATER QUALITY PROTECTION. L. M. Wax, E. W. Stoller, J. W. Hummel, D. M. Alm, and M. D. Cahn, USDA-ARS, and L. E. Bode, University of Illinois. Report Period: 4/90 - 2/92.

INDIANA & GEORGIA DECISION SUPPORT SYSTEMS FOR EVALUATING GROUNDWATER QUALITY PROBLEMS. B. A. Engel, Purdue University, D. B. Beasley, University of Georgia, K. M. Embleton, J. P. Gurganus, X. Zhuang, L. Rhykerd, D. D. Jones, Purdue University, M. C. Smith, W. G. Knisel, University of Georgia, R. A. Leonard, USDA-ARS, Tifton, GA. Report Period: 6/90 - 2/92.
INDIANA FIELD SCALE PREFERENTIAL FLOW ON STRUCTURED AND NON-STRUCTURED SILT LOAM SOILS. E. J. Kladivko, R. F. Turco, G. E. VanScoyoc, J. D. Eigel, Purdue University. Report Period: 9/91 - 2/92.
INDIANA CONTROLLED RELEASE HERBICIDE FORMULATIONS - THEIR EFFICACY AND ROLE REDUCING GROUNDWATER CONTAMINATION. M. M. Schreiber and M. V. Hickman, West Lafayette, IN, both USDA-ARS. Report Period: 1/90 - 2/92.

IOWA AVAILABILITY OF ORGANIC CARBON FOR DENITRIFICATION OF NITRATE IN SUBSOILS AND GROUNDWATERS. J. M. Bremner and G. W. McCarty, Iowa State Univ. Rpt Period: 9/89 - 2/92.
IOWA ANALYTICAL DETECTION OF CHEMICALS IN THE SOIL AND GROUND WATER. J. L. Hatfield, and R. L. Pfeiffer, USDA-ARS, Ames, Iowa. Report Period: 3/90 - 2/92.
IOWA DEVELOPMENT OF FARMING MANAGEMENT SYSTEMS TO IMPROVE WATER QUALITY. J. L. Hatfield, T. B. Moorman, and T. R. Steinheimer, USDA-ARS, Ames, IA. Rpt Period: 3/90 - 2/92.
IOWA EVALUATION OF THE IMPACT OF CURRENT AND EMERGING FARMING SYSTEMS ON WATER QUALITY. J. L. Hatfield, USDA-ARS, Ames, Iowa, J. L. Baker, Iowa State University, and P. J. Soenksen, USGS, Iowa City, IA, **MSEA Project**. Report Period: 3/90 - 2/92.
IOWA TRANSPORT AND CHEMICAL TRANSFORMATION OF PESTICIDES IN AGRICULTURAL SYSTEMS. J. L. Hatfield, T. B. Moorman, T. R. Steinheimer, USDA-ARS, Ames, IA. Rpt Period: 2/90 - 2/92.
IOWA DECISION AID SYSTEMS FOR FARMING MANAGEMENT AND WATER QUALITY. D. B. Jaynes, J. L. Hatfield, and S. D. Logsdon, USDA-ARS, Ames, Iowa. Report Period: 8/90 - 2/92.
IOWA IMPACT OF PREFERENTIAL FLOW ON CHEMICAL AND WATER MOVEMENT IN AGRICULTURAL SYSTEMS. D. B. Jaynes, S. D. Logsdon, and J. L. Hatfield, USDA-ARS, Ames, Iowa. Report Period: 8/90 - 2/92.
IOWA GROUNDWATER RECHARGE AND CHEMICAL TRANSPORT IN TWO GLACIAL TILL CONFINING UNITS IN IOWA. R. S. Kanwar, W. W. Simpkins, R. O. Horton, T. E. Fenton, L. C. Jones, J. L. Baker, Iowa State Univ and G. R. Halberg, Iowa Dept of Nat Res, Iowa City, IA. Rpt Period: 7/90 - 2/92.

KENTUCKY IMPACT OF RIPARIAN VEGETATION ON WATER QUALITY: MODELING AND MEASUREMENT. B. J. Barfield, R. Blevins, V. P. Evangelou, D. I. Carey, A. W. Fogle, University of Kentucky, Lexington, KY. Report Period: 5/1/90 - 2/1/92.
KENTUCKY THE ROLE OF SEDIMENT IN NUTRIENT TRANSPORT IN A KARST GROUND WATER CATCHMENT. G. K. Felton, W. W. Frye, University of Kentucky. Report Period: 7/91 - 1/92.

LOUISIANA PERCEPTIONS OF WATER QUALITY PROBLEMS AMONG RURAL RESIDENTS OF THE SOUTHWEST LOUISIANA IRRIGATED RICE PRODUCTION REGION. E. J. Luzar and G. W. Wilkerson, Louisiana State University. Report Period: 5/90 - 2/92.
LOUISIANA ATRAZINE IN THE SOIL ROOT ZONE AND QUALITY OF GROUNDWATER OF SHALLOW WATER-TABLE SOILS. H. M. Selim, D. C. Johnson, and L. Ma, Louisiana State University Agricultural Center and L. M. Southwick, G. H. Willis, USDA-ARS. Report Period: 8/90 - 2/92.
LOUISIANA WATER MANAGEMENT FOR IMPROVED GROUNDWATER QUALITY AND FARM CHEMICAL USE EFFICIENCY. G. H. Willis, J. L. Fouss, J. S. Rogers, C. E. Carter, L. M. Southwick, Baton Rouge, LA, USDA-ARS. Report Period: 1/89 - 2/92.

MAINE & NEW HAMPSHIRE IMPACTS OF PRECOMMERCIAL THINNING AND FERTILIZATION ON WATER QUALITY. R. D. Briggs, University of Maine, J. W. Hornbeck, USDA Foreign Service, C. T. Smith, University of New Hampshire. Report Period: 5/91 - 2/92.

MARYLAND USDA-ARS PESTICIDE PROPERTIES DATABASE. B. Acock and P. Laster, Systems Research Laboratory and A. E. Herner, Environmental Chemistry Laboratory, ARS, NRI, Beltsville. Report Period: 1/91 - 3/92.
MARYLAND PREDICTION OF GROUNDWATER CONTAMINATION FROM GENETICALLY ENGINEERED MICROBES. J. S. Angle, R. L. Hill, University of Maryland. Report Period: 6/90 - 2/92.
MARYLAND DEGRADATION OF PESTICIDE WASTE BY OZONE AND MICROBIAL METABOLISM. C. J. Hapeman-Somich, D. R. Shelton, USDA-ARS, Beltsville, MD. Report Period: 7/90 - 2/92.
MARYLAND MINIMIZING THE EFFECT OF MACROPORE FLOW ON PESTICIDE LEACHING. A. R. Isensee, A. M. Sadeghi, T. J. Gish, W. J. Rawls, USDA-ARS. Report Period: 1/91 - 2/92.
MARYLAND SPATIAL AND TEMPORAL DISTRIBUTION OF AIRBORNE ORGANIC CONTAMINANTS IN WET AND DRY DEPOSITION. W. E. Johnson and C. S. Schomburg, USDA-ARS, Beltsville, MD. Report Period: 3/91 - 3/92.
MARYLAND & IDAHO NUTRIENT MANAGEMENT EXPERT SYSTEM. H. Lemmon, B. Acock, USDA-ARS, Beltsville, and J. Bartulovitch, University of Idaho. Report Period: 2/91 - 2/92.
MARYLAND EFFECT OF N PLACEMENT AND RIDGE TILLAGE ON NITRATE LEACHING AS TRACED BY BROMIDE. R. R. Weil and A. Shirmohammadi. University of Maryland at College Park. Report Period: 7/91 - 1/92.

MASSACHUSETTS & CONNECTICUT REGULATIONS AND ECONOMIC INCENTIVES FOR ACHIEVING GROUNDWATER QUALITY. C. R. Harper, C. E. Willis, J. T. Finn, University of Massachusetts, K. Segerson, University of Connecticut. Report Period: 7/91 - 2/92.
MASSACHUSETTS DAIRY MANURE ON ALFALFA TO REDUCE OVERAPPLICATION AND N LOSS FROM CORN FIELDS. S. J. Herbert, J. Daliparthy, P. L. M. Veneman and J. Moffitt, University of Massachusetts. Report Period: 6/90 - 2/92.

MICHIGAN, PENNSYLVANIA & MINNESOTA ASSESSMENT AND MODELING OF NITRATE LEACHING UNDER CONVENTIONAL AND ORGANICALLY MANAGED CORN. E. A. Paul, P. Grace, G. H. Harris, O. B. Hesterman, J. T. Ritchie, K. Paustian, Michigan State University, S. E. Peters, R. R. Janke, K. Kroll, Rodale Institute, J. A. E. Molina, Univ of Minnesota. Report Period: 7/90 - 2/92.
MICHIGAN & KANSAS STRATIFICATION AND FATE OF N WITHIN SOIL PROFILES: MANAGEMENT-INDUCED CHANGES. F. J. Pierce, J. R. Crum, B. D. Knezek, Michigan State University and C. W. Rice, M. D. Ransom, and R. E. Lamond, Kansas State University. Report Period: 4/90 - 3/91.

**MINNESOTA** A FIELD TRACER TEST METHOD FOR LARGE SOIL SAMPLES. E. C. Alexander, Jr., J. L. Nieber, University of Minnesota. Report Period: 6/91 - 2/92.

**MINNESOTA, WISCONSIN, N DAKOTA & S DAKOTA** NORTHERN CORNBELT SAND PLAINS MSEA. J. L. Anderson, University of Minnesota; R. H. Dowdy, USDA-ARS, St. Paul, MN; and G. N. Delin USGS, St. Paul, MN, **MSEA Project**. Report Period: 7/90 - 2/92.

**MINNESOTA** DEVELOP ALFALFA TO INCREASE $N_2$ FIXATION AND REDUCE NITROGEN LOSSES TO THE ENVIRONMENT. D. K. Barnes, M. P. Russelle, J. F. Lamb, and C. P. Vance, St. Paul, MN, USDA-ARS. Report Period: 2/91 - 2/92.

**MINNESOTA** EFFECTS OF SOIL FREEZING ON THE FATE OF SOIL APPLIED NITROGEN AND PESTICIDES. G. R. Benoit, J. A. Daniel, J. A. Staricka, Morris, MN, all USDA-ARS. Report Period: 1/90 - 2/92.

**MINNESOTA** SORPTION-DESORPTION PROCESSES AFFECTING PESTICIDE MOBILITY IN TILLED SOILS. C. E. Clapp, R. R. Allmaras, D. R. Linden, W. C. Koskinen, J. M. Baker, R. H. Dowdy, USDA-ARS, St. Paul, MN. Report Period: 7/90 - 2/92.

**MINNESOTA** WEED EMERGENCE MODELING FOR A WEED/CROP BIOECONOMIC EXPERT SYSTEM. F. Forcella, G. R. Benoit, USDA-ARS. Report Period: 1/90 - 2/92.

**MINNESOTA & IOWA** ROLE OF EARTHWORM MACROPORES IN PREFERENTIAL FLOW OF WATER AND CONTAMINANTS. S. C. Gupta, J. F. Moncrief, E. Munyankusi, A. Bhattacharjee, University of Minnesota, and É. C. Berry, USDA-ARS, Ames, IA. Report Period: 9/91 - 2/92.

**MINNESOTA & NEBRASKA** INTEGRATION OF N MANAGEMENT ALTERNATIVES TO MINIMIZE GROUNDWATER CONTAMINATION. G. Malzer, P. Robert, D. Baker, J. Moncrief, R. Levins, University of Minnesota. G. Hergert, D. Martin, D. Watts, University of Nebraska, J. Schepers, USDA-ARS, and R. Beck Cenex/Land-O-Lakes. Report Period: 8/89 - 2/92.

**MINNESOTA** ISOPOTENTIAL ION EXTRACTION OF PESTICIDES. A. Olness, N. T. Basta, USDA-ARS, Morris, MN. Report Period: 1/90 - 2/92.

**MINNESOTA, IOWA & WISCONSIN** REGIONAL ASSESSMENT OF SOIL NITROGEN TESTS IN IOWA, MINNESOTA, AND WISCONSIN. G. W. Randall, M. A. Schmitt, University of Minnesota, R. J. Killorn, R. Horton, M. Duffy, Iowa State University, and L. G. Bundy, P. Nowak, University of Wisconsin. Report Period: 5/91 - 2/92.

**MISSISSIPPI** IMPROVE WATER QUALITY BY DEVELOPMENT OF MORE EFFICIENT METHODS OF APPLYING HERBICIDES. J. E. Hanks, C. G. McWhorter, and K. D. Howard, USDA-ARS, Stoneville, Mississippi. Report Period: 2/91 - 2/92.

**MISSISSIPPI, IOWA & TENNESSEE** COTTON IRRIGATION AND THE EFFECTS ON HERBICIDE MOVEMENT, PERSISTENCE, AND CARRYOVER. C. E. Snipes, H. C. Pringle III, Mississippi State University, T. B. Moorman, Ames, IA, M. A. Locke, Stoneville, MS, USDA-ARS, and T. C. Mueller, University of Tennessee. Report Period: 4/90 - 2/92.

**MISSOURI** ALTERNATIVE MANAGEMENT SYSTEMS FOR ENHANCING WATER QUALITY IN AN AQUIFER UNDERLYING CLAYPAN SOILS. E. Alberts, USDA-ARS, A. Prato, and N. Kitchen, University of Missouri, **MSEA Project**. Report Period: 3/90 - 2/92.

**MISSOURI** *TRIPSACUM* AND OTHER CORN RELATIVES AS RESOURCES FOR OPTIMIZING PRODUCTION PRACTICES THAT AFFECT GROUND WATER QUALITY. E. H. Coe, Jr., B. D. Barry, L. L. Darrah, USDA-ARS, Columbia, MO; and C. A. Blakey, University of Missouri. Report Period: 2/91 - 2/92.

**MISSOURI** ROLE OF PLANT RHIZOSPHERE AND ASSOCIATED MICROFLORA IN PESTICIDES DEGRADATION. G. A. Buyanovsky, G. H. Wagner, University of Missouri, and R. J. Kremer, USDA-ARS. Report Period: 6/90 - 2/92.

**MISSOURI** MOVEMENT AND PERSISTENCE OF PESTICIDES IN HIGHLY AGGREGATED SOILS. C. J. Gantzer, G. A. Buyanosky, S. H. Anderson, S. Kapila, Univ of Missouri. Rpt Period: 7/89 - 2/92.

**MISSOURI** CT-MEASURED FRACTAL DIMENSION, LACUNARITY AND CRACK POROSITY RELATED TO TRANSPORT. R. L. Peyton, S. H. Anderson, C. J. Gantzer, J. U. Baer. University of Missouri-Columbia. Report Period: 9/91 - 2/92.

**MONTANA** VALIDATION OF TRANSPORT MODELS FOR PREDICTING MOVEMENT OF AGRICHEMICALS THROUGH SOILS. W. P. Inskeep, A. H. Ferguson, R. H. Lockerman, J. W. Bauder, J. S. Jacobsen, Montana State University. Report Period: 9/89 - 8/91.
**MONTANA** VALIDATION OF SOLUTE TRANSPORT MODELS UNDER VARYING MOISTURE REGIMES. W. P. Inskeep, S. D. Comfort, R. H. Lockerman, and J. S. Jacobsen, Montana State University. Report Period: 9/91 - 2/92.
**MONTANA, MINNESOTA & MAINE** A LAND AND MICROCLIMATE ON-FARM INFORMATION SYSTEM FOR GROUNDWATER PROTECTION. J. S. Jacobsen, G. A. Nielsen, J. P. Wilson, Montana State University, P. C. Robert, University of Minnesota, and D. A. Tyler, University of Maine. Report Period: 6/91 - 2/92.
**MONTANA** CROPPING SYSTEMS AND NON-POINT SOURCE GROUNDWATER POLLUTION. J. Johnson, D. Griffith, J. Bauder, J. Jacobsen, J. Wilson, J. Antle, Mont State Univ. Rpt Period: 9/91 - 2/92.

**NEBRASKA** MOVEMENT OF AGRICULTURAL CHEMICALS BENEATH CONSERVATION TILLED-FURROW IRRIGATED LAND. D. E. Eisenhauer, R. B. Ferguson, F. W. Roeth, R. S. Spalding, University of Nebraska. Report Period: 7/91 - 2/92.
**NEBRASKA** QUANTIFYING NITRATE LEACHING UNDER CONTINUOUS CORN VERSUS A CORN-SOYBEAN ROTATION. G. W. Hergert, N. L. Klocke, D. G. Watts, J. P. Schnekloth, University of Nebraska, and J. S. Schepers, USDA-ARS, Lincoln, NE. Report Period: 9/91 - 2/92.
**NEBRASKA** MANAGEMENT OF SOIL, WATER, AND NITROGEN RESOURCES TO PROTECT GROUNDWATER QUALITY. J. S. Schepers, D. D. Francis, W. W. Wilhelm, and J. F. Power, USDA-ARS, University of Nebraska, Lincoln, NE. Report Period: 5/90 - 3/92.
**NEBRASKA** REAL-TIME MEASUREMENTS OF HERBICIDE PERSISTENCE IN GROUND WATER. Roy F. Spalding and Vitaly Zlotnik, University of Nebraska; Douglas M. Mackay, William W-G Yeh, and James F. Barker, University of Waterloo. Report Period: 4/91 - 2/92.
**NEBRASKA** MANAGEMENT OF IRRIGATED CORN AND SOYBEANS TO MINIMIZE GROUNDWATER QUALITY. D. G. Watts, R. F. Spalding, and J. S. Schepers. University of Nebraska and USDA-ARS, Lincoln. **MSEA Project**. Report Period: 5/90 - 3/92.

**NEW MEXICO** CHEMICAL TRANSPORT AND PERSISTENCE IN A FURROW IRRIGATED NO-TILL MANAGEMENT SYSTEM. N. B. Christensen, J. Schroeder, T. L. Jones, New Mexico State University, J. M. H. Hendrickx, New Mexico Tech. Report Period: 5/91 - 2/92.

**NEW YORK** ELECTROCHEMICAL TREATMENT OF PESTICIDE WASTEWATER. A. T. Lemley, K. Pratap, Cornell University. Report Period: 6/90 - 3/92.
**NEW YORK & MASSACHUSETTS** REDUCING GROUNDWATER POLLUTION: A SYSTEMS ANALYSIS. C. A. Shoemaker and G. White, Cornell University and D. N. Ferro, University of Massachusetts. Report Period: 9/90 - 2/92.
**NEW YORK** INTERACTION OF PREFERENTIAL FLOW & BIODEGRATION IN HETEROGENEOUS SOILS. T. S. Steenhuis, M. Alexander, B. Pivetz, J. W. Kelsey, Cornell Univ. Rpt Period: 7/90 - 2/92.
**NEW YORK & NEW MEXICO** LOCATING SOIL LAYERS IN THE VADOSE ZONE WITH NONDESTRUCTIVE METHODS: ASSESSING VULNERABILITY TO CONTAMINATION OF AQUIFERS. T. S. Steenhuis, J.-Y. Parlange, L. M. Cathles, Cornell University; J. M. H. Hendrickx, J. Schlue, New Mexico Institute of Mining and Technology. Report Period: 8/91 - 2/92.
**NEW YORK & MARYLAND** PARAMETERIZATION OF TILLAGE EFFECTS ON SOIL HYDRAULIC PROPERTIES AND AGRICHEMICAL LOSSES. H. M. vanEs, J. L. Hutson, Cornell University, and R. L. Hill, University of Maryland. Report Period: 10/91 - 2/92.
**NEW YORK** MAPPING GROUNDWATER CONTAMINATION POTENTIAL USING INTEGRATED SIMULATION MODELING AND GIS. R. J. Wagenet, R. B. Bryant, S. D. DeGloria, Cornell University, Ithaca, NY, and R. G. Perritt, USDA-SCS, Syracuse, NY. Report Period: 9/89-2/92.
**NEW YORK & CONNECTICUT** PROTECTING GROUNDWATER FROM NITRATE ON DAIRY FARMS IN THE NORTHEAST. R. J. Wagenet, S. D. Klausner, and R. A. Milligan, Cornell University, S. R. Kaffka and V. R. Kanneganti, Sunny Valley Foundation, New Milford, CT. Rpt Period: 5/90 - 2/92.

NORTH CAROLINA PREFERENTIAL MOVEMENT OF WATER AND SOLUTES THROUGH SOIL/SAPROLITE SEQUENCES. A. Amoozegar, S. W. Buol, W. P. Robarge, M. J. Vepraskas, and R. M. Kretzschmar, North Carolina State University. Report Period: 7/91 - 2/92.

NORTH CAROLINA & VIRGINIA REMOVAL OF NONPOINT SOURCE POLLUTION BY VEGETATED AND RIPARIAN BUFFERS. J. W. Gilliam, J. E. Parsons, R. B. Daniels, North Carolina State University, and T. A. Dillaha, Virginia Polytechnic and State University. Report Period: 7/91 - 2/92.

NORTH CAROLINA GROUND WATER CONTAMINATION POTENTIAL USING MODELS, GIS, AND REMOTE SENSING. S. Khorram, R. L. Huffman, North Carolina State University. Report Period: 6/90 - 2/92.

NORTH CAROLINA EFFECTS OF WATER TABLE MANAGEMENT ON GROUNDWATER QUALITY. R. W. Skaggs, J. W. Gilliam, T. J. Sheets, R. O. Evans, J. E. Parsons, C. L. Munster, North Carolina State University. Report Period: 6/90 - 2/92.

OHIO SURFACE-SUBSURFACE WATER AND CHEMICAL MOVEMENT AND INTERACTIONS ON AGRICULTURAL WATERSHEDS. J. V. Bonta, W. M. Edwards, L. B. Owens, USDA-ARS, Coshocton, Ohio. Report Period: 1/90 - 2/92.

OHIO & INDIANA ROLE OF WATER TABLE POSITION AND HISTORY ON THE FATE OF SUBSURFACE CONTAMINANTS. L. C. Brown, S. J. Traina, The Ohio State University, R. F. Turco, Purdue University, and W. A. Dick, The Ohio State University. Report Period: 7/91 - 2/92.

OHIO WEED MANAGEMENT SYSTEMS TO REDUCE GROUNDWATER CONTAMINATION IN NO-TILL CORN. J. Cardina, W. A. Dick, and S. Kent Harrison, Ohio State University - Ohio Agricultural Research and Development Center. Report Period: 7/91 - 2/92.

OHIO WATER TABLE MANAGEMENT FOR CROP PRODUCTION AND GROUND WATER QUALITY PROTECTION. N. R. Fausey and R. L. Cooper, USDA-ARS, Columbus; A. D. Ward, T. J. Logan and J. G. Streeter, Ohio State University. Report Period: 1/90 - 2/92.

OHIO & MICHIGAN EFFECT OF SORPTION ON FATE OF PESTICIDES IN SUBSURFACE ENVIRONMENTS. S. J. Traina, G. K. Sims, T. J. Logan, Ohio State University and S. A. Boyd, Michigan State University. Report Period: 6/89 - 2/92.

OHIO ASSESSING AND MODELING WATER QUALITY BENEFITS OF WATER TABLE MANAGEMENT SYSTEMS. Andy Ward, Terry Logan, Scott Bair, The Ohio State University, Norm Fausey, USDA-ARS, Columbus. Report Period: 7/90 - 2/92.

OHIO THE OHIO BURIED VALLEY AQUIFER MANAGEMENT SYSTEMS EVALUATION AREA. Andy Ward, Scott Bair, Terry Logan, Sue Nokes, The Ohio State University, Norm Fausey, Steve Workman, USDA-ARS, Steve Hindall, Martha Jagucki, USGS. **MSEA Project**. Report Period: 4/90 - 2/92.

OKLAHOMA & FLORIDA AGRICULTURAL CHEMICAL IMPACT EVALUATION AND MANAGEMENT SYSTEM. D. L. Nofziger, C. T. Haan, Oklahoma State University, and A. G. Hornsby, University of Florida. Report Period: 7/89 - 7/91.

OKLAHOMA, FLORIDA & NORTH CAROLINA ECONOMICS OF MANAGING PESTICIDES TO REDUCE WATER QUALITY DEGRADATION. D. L. Nofziger, Oklahoma State University, A. G. Hornsby, University of Florida, Dana Hoag, North Carolina State University. Report Period: 7/91 - 2/92.

OKLAHOMA ECONOMIC IMPACTS OF GROUND WATER QUALITY MANAGEMENT. P. E. Norris, H. P. Mapp, D. L. Nofziger, C. T. Haan, Oklahoma State University. Report Period: 7/91 - 2/92.

OKLAHOMA PREVENTION OF GROUND AND SURFACE WATER CONTAMINATION BY NEW AGRICULTURAL MANAGEMENT SYSTEMS. S. J. Smith, A. N. Sharpley, and J. W. Naney, USDA-ARS, Durant, OK. Report Period: 2/91 - 2/92.

OKLAHOMA & TEXAS WATER QUALITY IMPLICATIONS OF PLAYA LAKE CONTAINMENT OF FEEDLOT WASTES. S. J. Smith, A. N. Sharpley, and J. W. Naney, Durant, OK, and B. A. Stewart, Bushland, TX, all USDA-ARS. Report Period: 2/91 - 2/92.

OREGON NONPOINT SOURCE POLLUTION AND AGRICULTURAL PRACTICES: SOURCE TERM, MIXING ZONE, AND THE STEADY STATE CONDITION. L. Boersma, R. Mason, Oregon State University. Report Period: 9/89 - 2/92.

**OREGON** DYNAMIC MODELING OF ALTERNATING-FURROW IRRIGATION TO MINIMIZE NITRATE LEACHING TO GROUNDWATER. A. R. Mitchell, C. C. Shock, G. M. Perry, Oregon State University. Report Period: 4/91 - 2/92.
**OREGON** FATE AND CYCLING OF 15N-LABELLED DAIRY MANURE. D. D. Myrold, J. A. Moore, M. Gamroth, and J. E. Thies, Oregon State University. Report Period: 6/90 - 2/92.
**OREGON & NEW YORK** DEVELOPMENT AND TESTING OF WICK LYSIMETERS FOR OBSERVATION OF SOLUTE TRANSPORT. J. S. Selker, J. Moore at Oregon State University, and T. S. Steenhuis, J.-Y. Parlange at Cornell University. Report Period: 6/91 - 3/92.

**PENNSYLVANIA** SOIL MANAGEMENT OF RESIDUAL MANURE NITROGEN AFFECTING NITRATES IN GROUND WATER WITHIN LIMESTONE TERRAIN IN LANCASTER COUNTY, PA. D. E. Baker, A. T. Phillips, J. P. Senft, C. S. Baker, Penn State University. Report Period: 7/90 - 2/92.
**PENNSYLVANIA** USE OF MICROORGANISMS OR ENZYMES FOR DECONTAMINATION OF PESTICIDE-POLLUTED SOIL AND WATER. J.-M. Bollag, S.-Y. Liu, Penn State Univ. Rpt Period: 10/89 - 9/91.
**PENNSYLVANIA** ESTIMATION OF ANION TRANSPORT IN SOILS USING ZERO-TENSION LYSIMETERS. R. H. Fox and D. D. Fritton. The Pennsylvania State University. Report Period: 9/89 - 8/91.
**PENNSYLVANIA** NITRATE LEACHING IN CONTINUOUS CORN AND MANURED CORN-ALFALFA ROTATIONS. R. H. Fox, D. D. Fritton, W. P. Piekielek, J. D. Toth, Pennsylvania State University. Report Period: 10/91 - 2/92.
**PENNSYLVANIA** MICROENCAPSULATION AND ADJUVANT EFFECTS ON HERBICIDE LEACHING AND PERSISTENCE. J. K. Hall, R. O. Mumma, N. L. Hartwig, L. D. Hoffman, Pennsylvania State University. Report Period: 5/90 - 2/92.
**PENNSYLVANIA** KARST AQUIFER POLLUTION ASSAY BY VULNERABILITY INDEX DETERMINATIONS. D. A. Kurtz, R. R. Parizek, Pennsylvania State University. Report Period: 5/91 - 2/92.
**PENNSYLVANIA** ENVIRONMENTAL TRACING OF CHEMICALS PATHWAYS IN CROPLAND WATERSHEDS. H. B. Pionke, USDA-ARS, University Park, PA. Report Period: 1/90 - 2/92.

**RHODE ISLAND** ATTENUATION OF GROUNDWATER NITRATE IN RIPARIAN BUFFER ZONES. A. J. Gold, C. G. McKiel, University of Rhode Island, and P. M. Groffman, Institute of Ecosystem Studies. Report Period: 5/91 - 2/92.

**SOUTH CAROLINA & NORTH CAROLINA** TERRAIN CONDUCTIVITY TO QUANTIFY IMPACT OF FARM LAGOONS UPON GROUNDWATER QUALITY. D. E. Brune, Clemson University, P. W. Westerman, North Carolina State University. Report Period: 9/89 - 8/91.
**SOUTH CAROLINA** IMPROVED IRRIGATION AND NITROGEN MANAGEMENT OF COTTON IN THE EASTERN COASTAL PLAIN. P. G. Hunt, C. R. Camp, and P. J. Bauer, USDA-ARS, Florence, SC. Report Period: 2/91 - 2/92.
**SOUTH CAROLINA** WATER QUALITY EVALUATION FOR DUPLIN COUNTY DEMONSTRATION PROJECT. P. G. Hunt, K. C. Stone, USDA-ARS, Florence, SC. Report Period: 9/90 - 2/92.
**SOUTH CAROLINA & KENTUCKY** GROUNDWATER QUALITY AS AFFECTED BY PREFERENTIAL FLOW IN STRUCTURED SOILS. V. L. Quisenberry and B. R. Smith, Clemson University and R. E. Phillips, University of Kentucky. Report Period: 10/89 - 2/92.
**SOUTH CAROLINA, KENTUCKY & ARKANSAS** SOIL CLASSIFICATION SYSTEM FOR SOUTHERN REGION BASED ON WATER AND CHEMICAL TRANSPORT. V. L. Quisenberry, Clemson University, R. E. Phillips, University of Kentucky, and H. D. Scott, Univ of Arkansas. Rpt Period: 7/91 - 2/92.

**SOUTH DAKOTA, MINNESOTA & COLORADO** TILLAGE INDUCED MICRORELIEF IMPACT ON $NO_3$ AND ATRAZINE MOVEMENT IN SOILS. D. E. Clay, T. E. Schumacher, S. A. Clay, and J. A. Bischoff, South Dakota State University; G. L. Malzer, University of Minnesota; M. J. Shaffer, USDA-ARS, Fort Collins. Report Period: 4/91 - 2/92.

**SOUTH DAKOTA** DEVELOP TECHNOLOGIES FOR MANAGING CORN ROOTWORM POPULATIONS WITH REDUCED INSECTICIDE INPUTS. G. R. Sutter, W. D. Woodson, M. M. Ellsbury, L. S. Hesler, Brookings, SD, USDA-ARS. Report Period: 4/90 - 2/92.

**TENNESSEE & LOUISIANA** THE EFFECTS OF TILLAGE ON FATE AND TRANSPORT OF PESTICIDES THROUGH UNSATURATED SOIL PROFILES. M. E. Essington, G. V. Wilson, and D. D. Tyler, University of Tennessee, and H. M. Selim, Louisiana State University. Report Period: 7/91 - 2/92.

**TENNESSEE & KENTUCKY** EFFECTS OF TILLAGE AND CROPPING SYSTEMS ON TRANSPORT OF NITRATE THROUGH HETEROGENEOUS SOILS. G. V. Wilson, D. D. Tyler, J. Logan, University of Tennessee, and G. W. Thomas, R. L. Blevins, University of Kentucky. Report Period: 5/90 - 2/92.

**TEXAS** PESTICIDE DEGRADATION BY A GENETICALLY ENGINEERED FUNGUS. C. M. Kennerley, A. Garcia III, Texas A&M University. Report Period: 9/91 - 2/92.

**TEXAS** HYDRAULIC CONDUCTIVITY AND MACROPORE FLOW IN RELATION TO SOIL STRUCTURE. K. J. McInnes, L. P. Wilding, and C. T. Hallmark, Texas A&M University. Report Period: 6/90 - 2/92.

**TEXAS** DEVELOP COMPREHENSIVE WATER QUALITY MANAGEMENT MODELS. J. R. Williams and C. W. Richardson, USDA-ARS, Temple, TX. Report Period: 2/91 - 2/92.

**TEXAS, GEORGIA & FLORIDA** MANAGEMENT OF DAIRY WASTE TO MINIMIZE POTENTIAL GROUNDWATER CONTAMINATION. M. L. Wolfe, M. A. Sanderson, K. J. McInnes, Texas A&M Univ, and M. Cabrera, Univ of Georgia, A. R. Overman, Univ of Florida. Report Period: 7/91 - 2/92.

**UTAH** OPTIMIZING IRRIGATION MANAGEMENT FOR POLLUTION CONTROL AND SUSTAINABLE CROP YIELDS. L. M. Dudley, R. J. Hanks, R. C. Peralta, Utah State Univ. Report Period: 9/89 - 2/92.

**UTAH** ECONOMIC INCENTIVES FOR MANAGING NON-POINT PESTICIDE POLLUTION OF GROUNDWATER: A PROTOTYPE APPLICATION. T. F. Glover, R. C. Peralta, H. H. Fullerton, Utah State University. Report Period: 9/90 - 2/92.

**VERMONT** EFFECTS OF CORN MANAGEMENT SYSTEMS ON NITRATE LEACHING POTENTIAL. F. R. Magdoff, W. E. Jokela, R. P. Durieux, H. R. Brown, Univ of Vermont. Rpt Period: 8/89 - 12/91.

**VERMONT & NEW YORK** NITROGEN MANAGEMENT SYSTEMS FOR CORN TO REDUCE NITRATE LEACHING. F. R. Magdoff, W. E. Jokela, R. P. Durieux, University of Vermont, H. Van Es, S. D. Klausner, L. D. Geohring, Cornell University. Report Period: 5/91 - 2/92.

**VIRGINIA** SOIL MINERAL NITROGEN AS A PREDICTOR OF NITROGEN FERTILIZER NEED OF WINTER WHEAT. M. M. Alley, P. C. Scharf, Virginia Polytechnic Inst & State Univ. Rpt Per: 7/90 - 2/92.

**VIRGINIA** COMPOSTING AS A MEANS TO DISPOSE OF PESTICIDE WASTE. D. F. Berry, D. E. Mullins, G. H. Hetzel, R. W. Young, Virginia Polytechnic Institute & State Univ. Rpt Period: 7/90 - 2/92.

**WASHINGTON** DEVELOPMENT OF A SPATIAL DECISION SYSTEM FOR FARM MANAGEMENT OF NITROGEN FERTILIZER APPLICATIONS. D. J. Mulla and G. S. Campbell, Washington State University. Report Period: 8/89 - 7/91.

**WASHINGTON & OREGON** ON-FARM MANAGEMENT OF GROUNDWATER NITRATE POLLUTION IN PACIFIC NORTHWEST IRRIGATED AGRICULTURE. N. K. Whittlesey, D. Mulla, M. Frasier, Washington State University, R. Adams, G. Perry, M. English, Oregon State University. (Three awards). Report Period: 7/89 - 2/92.

**WEST VIRGINIA** NEMATICIDE MOBILITY AND BIODEGRADATION: EFFECTS OF ORCHARD SOIL MANAGEMENT. J. Kotcon, A. Sexstone, West Virginia University, D. Glenn, USDA, Kearneysville, WV. Report Period: 5/90 - 3/92.

**WEST VIRGINIA** WATER QUALITY IMPACTS OF AGRICULTURE IN SOUTHEAST WEST VIRGINIA. G. C. Pasquarell, D. G. Boyer, D. P. Bligh, USDA-ARS, Beckley, WV. Rpt Per: 7/90 - 2/92.

**WEST VIRGINIA** BACTERIAL QUALITY OF POINT-OF-USE FILTERS USED FOR TREATMENT OF RURAL GROUNDWATER SUPPLIES. J. W. Snyder, C. N. Mains, R. E. Anderson, and G. K. Bissonnette, West Virginia University. Report Period: 8/89 - 8/91.

**WISCONSIN** SAFE ON-FARM DISPOSAL OF DILUTE PESTICIDE WASTES. G. Chesters, J. M. Harkin, M. A. Anderson, H. W. Read, M. A. Aguado, C.-P. Chen, University of Wisconsin-Madison. Report Period: 7/90 - 2/92.

**WISCONSIN & NEW YORK** USING GROUND PENETRATING RADAR TO IMPROVE MONITORING AND PREDICTING PREFERENTIAL SOLUTE MOVEMENT IN SANDY SOILS. K-J. S. Kung, University of Wisconsin-Madison; T. S. Steenhuis, J-Y. Parlange, Cornell Univ. Report Period: 6/90 - 2/92.

**WISCONSIN** MOVEMENT OF ATRAZINE AND ALACHLOR THROUGH THE UNSATURATED ZONE: MODEL CALIBRATION AND VALIDATION. K. Mc Sweeney and B. Lowery, University of Wisconsin, Madison. Report Period: 6/89 - 2/92.

**WISCONSIN** PREFERENTIAL MOVEMENT OF WATER AND AGCHEMICALS IN SANDY SOIL WITH ANIMAL BURROWS. J. M. Norman, K. McSweeney, B. Lowery, Univ of WI. Rpt Per: 7/91 - 1/92.